| GLAST LAT PROCESS SPECIFICATION | Document # **LAT-PS-00254-01** | Date Effective 12 July 2001 |
|---|---|---|
| | Prepared by(s) S. Carius, G. Johansson, L. Nilsson | Supersedes None |
| | Subsystem/Office Calorimeter Subsystem | |

Document Title

# CsI Crystal Optical Test Bench Operating Procedure

## CHANGE HISTORY LOG

| Revision | Effective Date | Description of Changes |
|---|---|---|
| 1 | 12 July 2001 | Initial Release |
| | | |

## 1 Summary

This document shortly describes how to operate the optical test equipment that are going to be used for measuring optical properties of the CsI crystals for the GLAST calorimeter as specified in the purchase order. Given is an instruction of how to handle the equipment and how to perform the light tapering measurements. The procedure is described in several sections placed in the same order they should be needed when using the equipment.

Before the equipment can be used for optical tests of crystals, a number of settings and adjustments have to be made, except assembling and cabling, as well as initialization of the software. The appropriate high voltage (HV) for the photomultiplier tubes (PMT) should be determined along with amplifiers gain values (see section 7).

## 2 Reference Documents

Calorimeter Crystal Optical Test Station Software Requirements, LAT-DS-00108

Calorimeter Crystal Optical Test Station ADC Control Design Description, LAT-DS-00255

## 3 Test Setup

The test equipment is schematically shown in fig. 1 and consists of an optically closed test box and a data acquisition system (DAS). The test box (in the following referred to as the dark chamber, DC) houses the motor slide to move the $^{22}$Na source longitudinally along the crystal and the PMTs. The DAS comprises three major parts: a NIM crate with front-end electronics, a motor controller (MC) unit (Velmex, inc. *VP 9000 Controller*) and the data acquisition computer (DAC). The NIM crate contains five units: a dual HV unit (Canberra *DUAL H.V. SUPPLY 3125*; fig. 2), two ADCs (Canberra *ADC 8701*; fig. 3a), a dual amplifier unit (ORTEC EG&G *855 DUAL SPEC AMP*; fig. 3b), and an IO-board unit for communication between the DAC and the front-end electronics (ADCs and HV unit).

Cable connections are in fig. 1 marked with circulated numbers. These refer to the numbers in column one in table 1. Columns two and three define the connections.

Before any optical measurement can be done, the silicon slabs have to be attached to the PMT front glass as optical connections to the crystal. The silicon slab has about twice the diameter of the PMT. Be sure only to grab the slab at its edges and not to touch the part of it, which will be in front of the photocathode. When attaching the silicon slab to the PMT front glass, carefully check that there are no air inclosures between the glass and the silicon. This would deteriorate the optical connection between the crystal and the PMT.

## 4 Power-up Procedure

After the equipment has been assembled and cabling has been completed, begin the startup of the system by switching on the power on the NIM crate, the motor controller (MC) and the data acquisition computer (DAC):

1. Switch on the power in the NIM crate. The power switch is located on the front panel of the power unit in the right-most position in the crate. The red lamp above the switch lights up as the power comes on. Also the green lamp marked "POWER" on the IO-board unit should light up as well as the two red lights marked "*NEG*" on the HV unit (fig. 2).

2. Switch on the power on the motor controller. The switch is located in the lower right corner of the unit. As the power comes on the display should light up.

3. Power up the computer. The button is located in the upper right corner. Also make sure the power is on on the screen monitor. The button is located in the lower right corner of the monitor.

*Table 1: cable connections.*

| No. | "from" connection | "to" connection | cable type |
|---|---|---|---|
| 1 | HV unit, channel B | left PMT | HV coax |
| 2 | HV unit, channel A | right PMT | HV coax |
| 3 | left PMT | Amp, lower channel | signal coax |
| 4 | right PMT | Amp, upper channel | signal coax |
| 5 | Amp, lower channel | ADC unit 0 | signal coax |
| 6 | Amp, upper channel | ADC unit 1 | signal coax |
| 7 | ADC unit 0 | IO-board | flatband |
| 8 | ADC unit 1 | IO-board | flatband |
| 9 | IO-board | DAC | multi signal |
| 10 | IO-board | HV unit | multi signal |
| 11 | DAC | MC | multi signal |
| 12 | MC | Motor slide | 2 cables: power + signal |

## 5 Startup Procedure for the Data Acquisition Program

After the equipment has been powered, the data acquisition program (DAP) should be started. Please follow the steps listed below after having opened the "*My computer*" icon.

1. The DAP is located in the folder *C:\Glast\Software\Data Acquisition*. Double-click on the folders/icons along this path until the program starts. Upon start it will initialize the MC. One can clearly hear the noise from the DC as the motor slide searches for its home position. If the MC is not powered you will get a message on the screen saying "*Please turn on the motor controller and then press OK*". The same is if the NIM crate is not powered, you get a message saying "*Please turn on the NIM-BIN and then press OK*".

2. The program displays a dialog window on the screen (see fig. 4). Fill in the serial number (S/N) of the crystal to be measured in the dialog field named "*Crystal ID*". Fill in your name in the field "*Operator*", the location of your lab in the field "*Operator's Location*". You should also append the crystal S/N in the field "*Data Directory*" after the default string *C:\Glast*. The result should be a string like *C:\Glast\32K4-4-4*. The folder with the same name has to be created outside the program. You may also add any comment in the field "*Comments*" if applicable.

3. Read air temperature and humidity from the gauge inside the box, and type in the values in the fields named "*Temperature*" and "*Humidity*", respectively, under the header "*Environmental Settings*".

## 6 Settings of Front-end Electronics

Before starting an optical measurement the following settings should be carefully checked. Remember to always check that the DC is closed before starting a measurement or turning on HV.

1. HV settings for the PMT. Under the header "*High Voltage Controls*" in the DAP there are two fields named "*Left PMT High Voltage*" and "*Right PMT High Voltage*". Check that the correct HV values are written in these fields (e.g. –1240 V and –1340 V). In addition, make sure that both the red lamps on the NIM HV unit (fig. 2) are indicating "*NEG*" voltage (polarity is changeable under the unit's cover). Also make sure that the switch on the pack plane of the HV unit is in the position marked "*REM*" for remote control mode.

2. ADC settings. Under the header "*ADC Settings*" in the DAP there are two fields named "*ADC Range*" and "*ADC Gain*". Both should be set to the value 1024. The fields "*LLD 0*" and "*LLD 1*" should both be set to the value 20. The Canberra *ADC 8701* modules should both have the following settings on their front panels (cf. fig. 3a). The knobs for *Range* and *Gain* should both be set to the value 1K. All the six switches under "*OFFSET*" should be in their lower positions. The leftmost switch named "*PEAK DETECT*" should be in its upper position marked "*AUTO*". The two lowest switches to the right should both be in their upper positions marked "*PHA*" and "*COINC*", respectively.

3. Amplifier settings. Under the header "*Shaper Settings*" in the DAP there are four fields named "*ADC_0 Fine Gain*", "*ADC_1 Fine Gain*", "*ADC_0 Coarse Gain*" and "*ADC_1 Coarse Gain*". These fields should show the same values as the settings on the ORTEC EG&G *855 DUAL SPEC AMP* module (fig. 3b). See section 7.

4. The length of the time interval during which data will be accumulated is set in the field named "*Accumulation Time (sec)*" in the DAP. This should be set to such a value that enough statistics is acquired to obtain an adequate fit of the 511 keV peak. The length of the acquisition time has thus to match the strength of the radioactive $^{22}$Na source. E.g., with a 10 μC source 500 s is adequate.

5. Defining the scan positions. The position values should be given to the DAP under the header "*Scan Positions to be analyzed (mm)*". 11 equally spaced positions should be specified in mm. The left-most position should be 20 mm from the left end of the crystal, the right-most position 20 mm from its right end. If the crystal is accurately positioned between the PMTs, and if the home position of the motor slide is correctly found, the scan position values should be: 20, 49, 78, 107, 136, 165, 194, 223, 252, 281 and 313.

6. Histogramming option. Under the header "*Data Mode*" in the DAP the setting should normally be "*List mode with histogram data*".

## 7 Procedure for Optical Measurements of Crystals

Make sure HV voltage is off before opening the DC.

1. Place the crystal on the support between the PMTs with its S/N label facing upwards and turned so that the label can be read normally. Make sure the backside of the crystal is everywhere in contact with the rear wall of the support.

2. Press the crystal gently against the silicon slab in front of the left PMT.

3. Turn the crank on the right PMT counter-clockwise to apply pressure on the crystal ends. Beside the right PMT there is a red lamp. This lamp is initially on. Correct pressure is achieved when the red light turns off.

4. Close the DC and lock the door.

5. Turn on the HV (switch in upper position; see fig. 2). Make sure the HV unit is set to negative voltage (cf. 1. of section 5).

6. To start the data acquisition, click the oval button icon labeled "*Start Acquisition*" in the lower right corner of the DAP dialog window.

7. The DAP now opens a new dialog window on the screen. Check the box labeled "*Current Output File*". It should show a text string of the form *C:\Glast\32K4-4-4\32K4-4-4_20_a.lis*, where "*_20*" marks the scan position for this particular measurement and "*_a*" is a version number. If a file with this name already exists in the folder, the program will instead write "*_b*", and so on. This syntax of the file name is significant as the files will be read by the subsequent fitting program (see section 8). For a detailed description please refer to the note LAT-DS-00108 by Eric Grove.

## 8 Finding HV setting for PMTs

To adjust the HV for the PMTs, position the $^{22}$Na source 20 mm from the left end of the crystal and monitor the closest PMT. Set the HV for this PMT to –1250 V. Adjust the pole-0 filter to minimize the over-/under-shoot on the signal by turning the screw marked PZ on the amplifier (fig. 3b). Adjust the gain so that the 511 keV peak appears around channel 250 in the histogram. Set the right PMT's amplifier to the same gain value. Turn on the HV for the right PMT and adjust the pole-0 filter. Adjust the HV so that the 511 keV peak appears around the same histogram channel as for the left PMT.

## 9 Data Fitting Procedure

The fitting program is located in the catalogue *C:\Glast\Software\Fitting*.

1. Start the fitting program. The program will display a dialog window on the screen (fig. 5).

2. Fill in the fields "*Crystal ID*", "*Operator*", "*Operator's Location*" and "*Comments*" (if applicable).

3. In the field "*Data Directory*" append the crystal S/N to the default string *C:\Glast*.

4. In the field "*Output Directory*" append the crystal S/N immediately followed by the string "*\graphs*". The result should be a string like "*C:\Glast\32K4-4-4\graphs*". A folder with the same name has to be created outside the program.

5. In the middle column, press the button "*Load Positions From Data Directory*" and make sure that the "*Latest version*" corresponds to what is defined in the DAP (cf. 7. in the section 6).

6. The field "*Format*" under the header "*Save plot of spectral fits?*" should be "*JPEG*", and the box to the left of the header should be checked.

7. If it is desired to check every single spectrum and the fit of it, the box to the left of "*Confirm fits before proceeding?*" should be checked.

8. The box to the left of "*Also show full spectrum?*" is checked by default.

9. Start values for fit parameters. The start values for the parameters in the left column under the header "*Search Constraint*" should be as given in table 1.

***Table 1: start values for fit parameters.***

| Search constraint | Value |
|---|---|
| *Smoothing window (bins)* | 30 |
| *Threshold bin* | 50 |
| *Start of fit range, multiplier* | 0.6 |
| *Lower bound of start of fit range (bins)* | 100 |
| *End of fit range, multiplier* | 1.6 |
| *Lower bound of end of fit range (bins)* | 300 |
| *Upper bound of end of fit range (bins)* | 900 |

| | |
|---|---|
| *Number of bins averaged to constant bkg level* | 10 |

10. Click the button icon “*Start Fitting Routine*”.
11. When the fitting of all the 11 spectra from the 11 scanning positions are done, the program will display a diagram showing the mean values of the fitted gaussians as a function of scanning position. When this light-tapering diagram appears on the screen, click the button “*Ready to proceed?*” in order to save the plot to disk.

## 10 Shutting down the Equipment

1. Switch off HV on the Camberra HV unit front panel.
2. Close all software.
3. In the start menu on the desktop, choose “Shut Down”, make sure the choice “Shut down the computer?” is filled in and then click “Yes”.
4. Switch off the screen monitor.
5. Switch off the NIM crate power and MC power.

## 11 Utilizing the Reference Crystal to Calibrate the Equipment

TBD

***FIGURE CAPTIONS***

Fig. 1: Block diagram for the test setup including cable connections.
Fig. 2: Front panel view of NIM HV unit.
Fig. 3: a) Front panel view of NIM ADC units.
b) Front panel view of NIM amplifier unit.
Fig. 4: Main dialog window of data acquisition program.
Fig. 5: Main dialog window of fitting program.

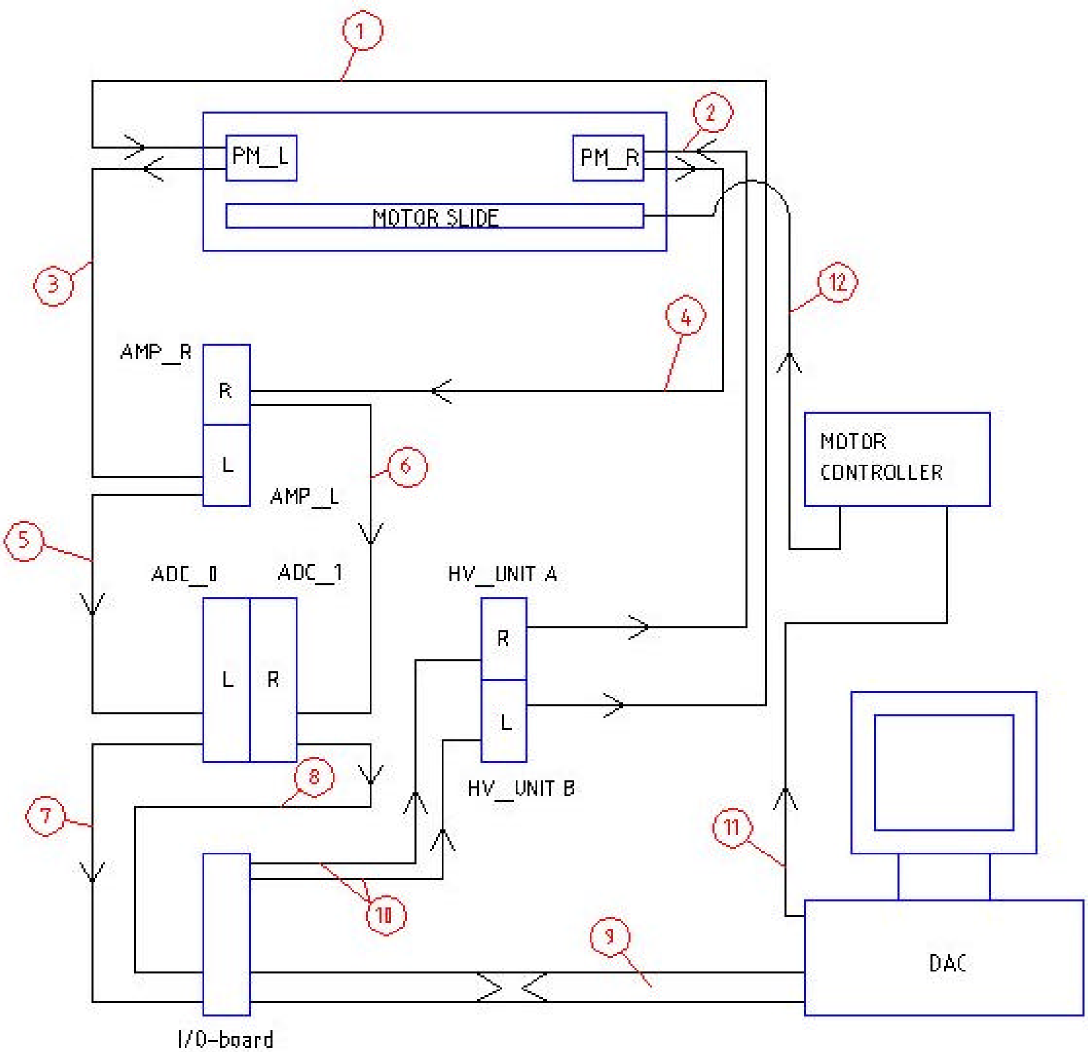


**Fig. 1**


Fig. 2


Fig. 3a Fig. 3b

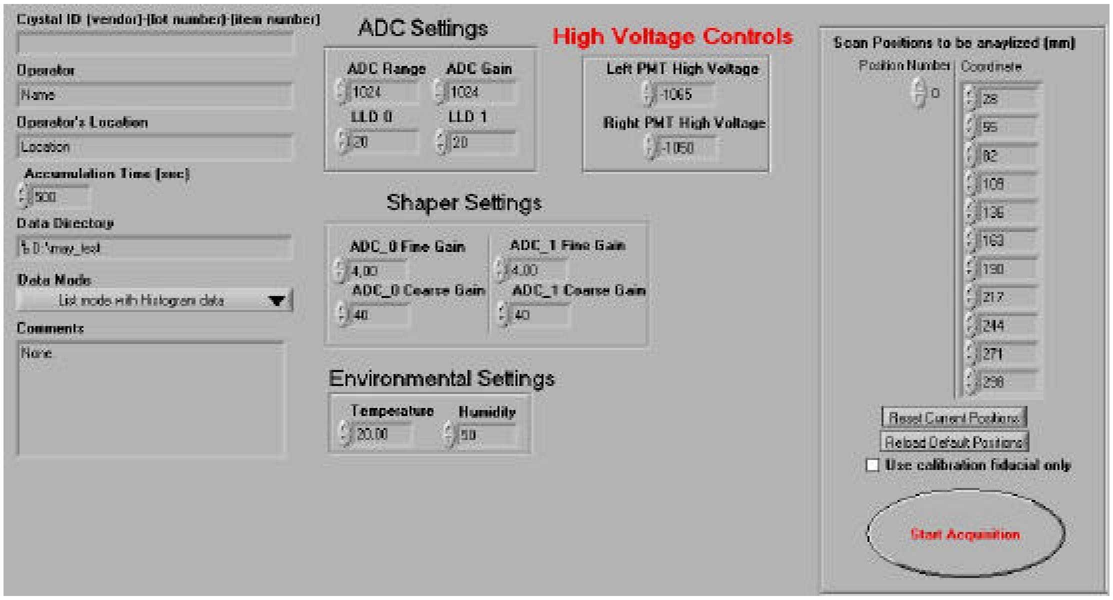
Crystal ID (vendor)-(lot number)-(item number)
Operator
Name
Operator's Location
Location
Accumulation Time (sec)
500
Data Directory
D:\may_test
Data Mode
List mode with Histogram data
Comments
None
ADC Settings
ADC Range
ADC Gain
1024
1024
LLD 0
LLD 1
20
20
High Voltage Controls
Left PMT High Voltage
-1065
Right PMT High Voltage
-1050
Shaper Settings
ADC_0 Fine Gain
ADC_1 Fine Gain
4.00
4.00
ADC_0 Coarse Gain
ADC_1 Coarse Gain
40
40
Environmental Settings
Temperature
Humidity
20.00
50
Scan Positions to be analyzed (mm)
Position Number
Coordinate
0
28
55
82
109
136
163
190
217
244
271
298
Reset Current Positions
Reload Default Positions
Use calibration fiducial only
Start Acquisition

**Fig. 4**

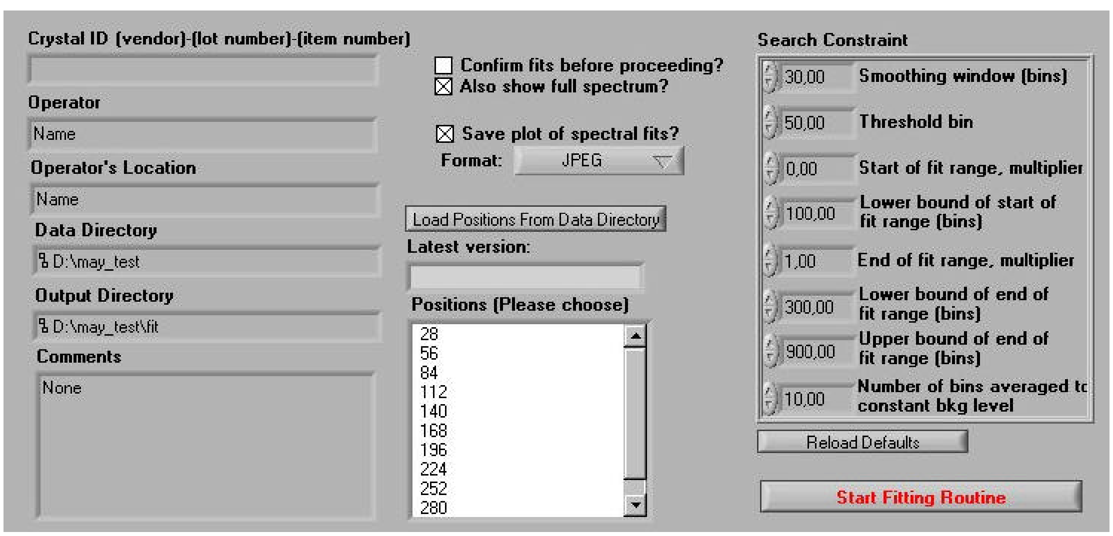
Crystal ID (vendor)-(lot number)-(item number)
Operator
Name
Operator's Location
Name
Data Directory
D:\may_test
Output Directory
D:\may_test\fit
Comments
None
Confirm fits before proceeding?
Also show full spectrum?
Save plot of spectral fits?
Format:
JPEG
Load Positions From Data Directory
Latest version:
Positions (Please choose)
28
56
84
112
140
168
196
224
252
280
Search Constraint
30,00
Smoothing window (bins)
50,00
Threshold bin
0,00
Start of fit range, multiplier
100,00
Lower bound of start of fit range (bins)
1,00
End of fit range, multiplier
300,00
Lower bound of end of fit range (bins)
900,00
Upper bound of end of fit range (bins)
10,00
Number of bins averaged tc constant bkg level
Reload Defaults
Start Fitting Routine

**Fig. 5**